

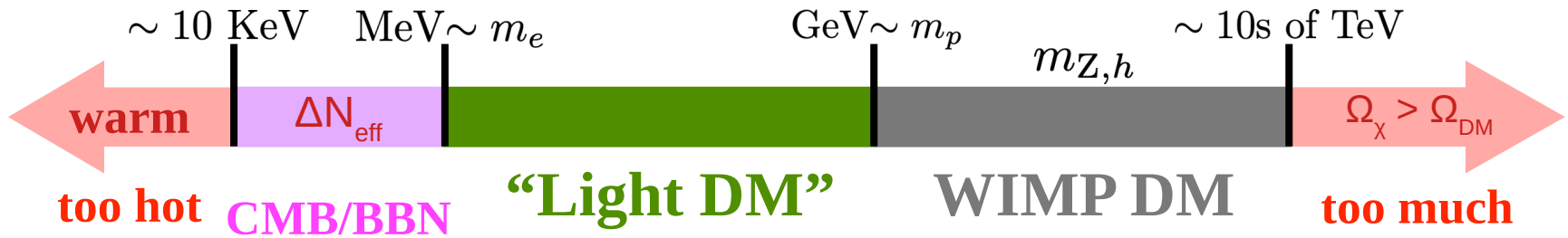
The Heavy Photon Search Experiment

Cameron Bravo (SLAC)

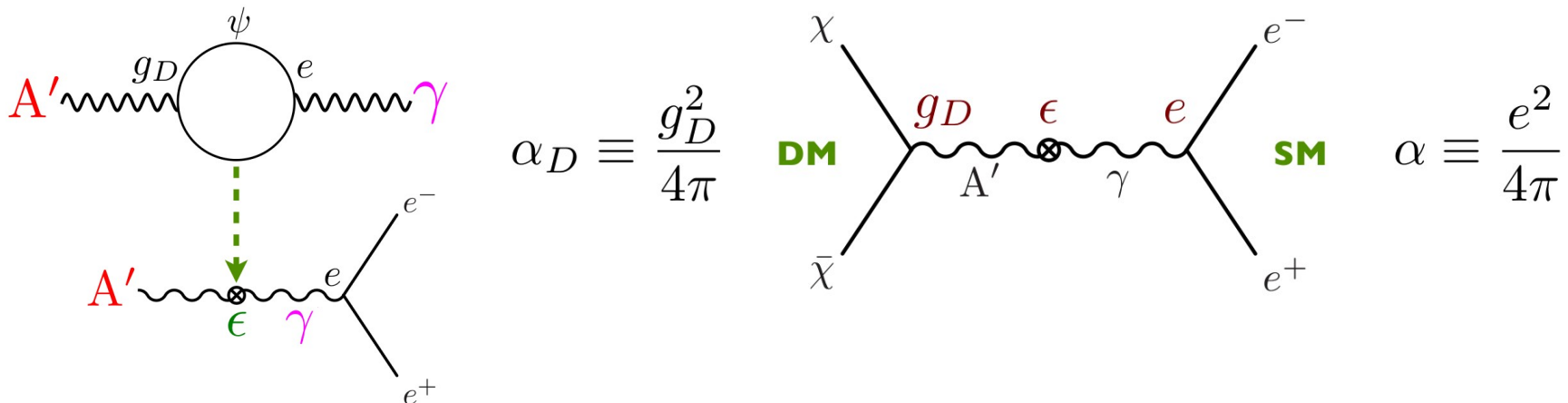


- What is the physics / motivation for your LOI?
- What will you work on between now and Snowmass, and what is your schedule for developing a contributed paper?
- What common data sets, joint efforts, etc. do you need?
- What would you like to come out of the Snowmass process?

Physics Motivation: Dark Sectors



- HPS currently focuses on the case where DM interacts via a light vector mediator
Holdom, Phys. Lett. B 166, 1986



Parameter Space: Mediator Decays to SM

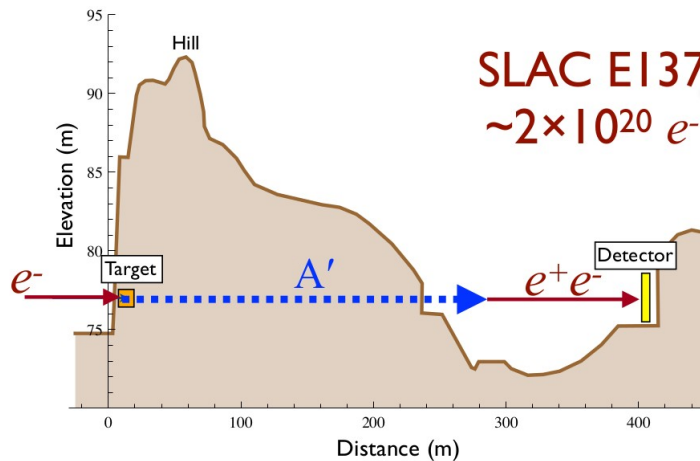
Generally, searches are “bump hunts” for $m(l^+l^-)$ resonances.



A' becomes long lived at small couplings.

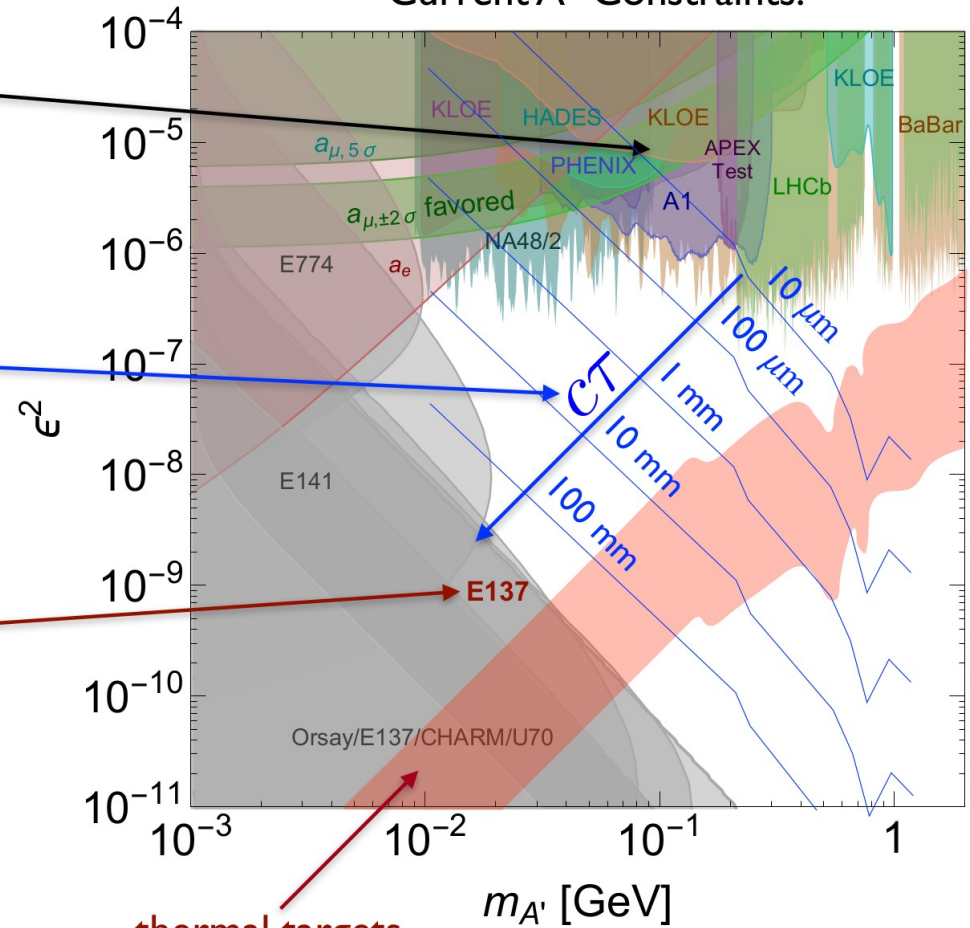
$$\gamma_{CT} \propto \frac{1}{\epsilon^2 m_{A'}^2}$$

Leads to constraints from “beam dump experiments”



SLAC E137
 $\sim 2 \times 10^{20} e^-$

Current A' Constraints:

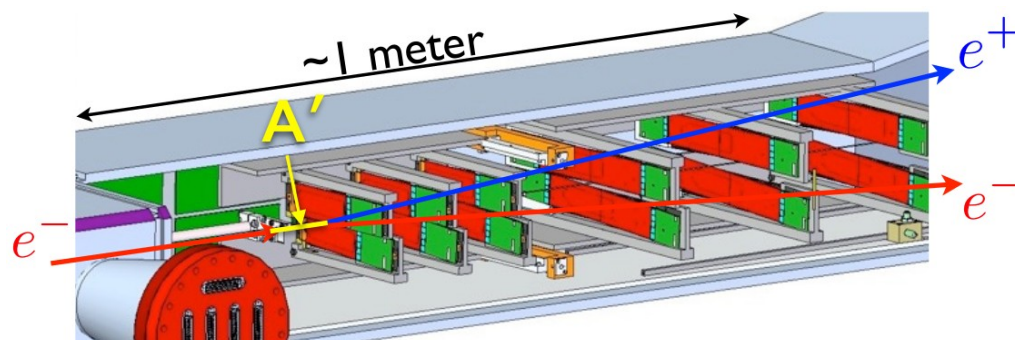
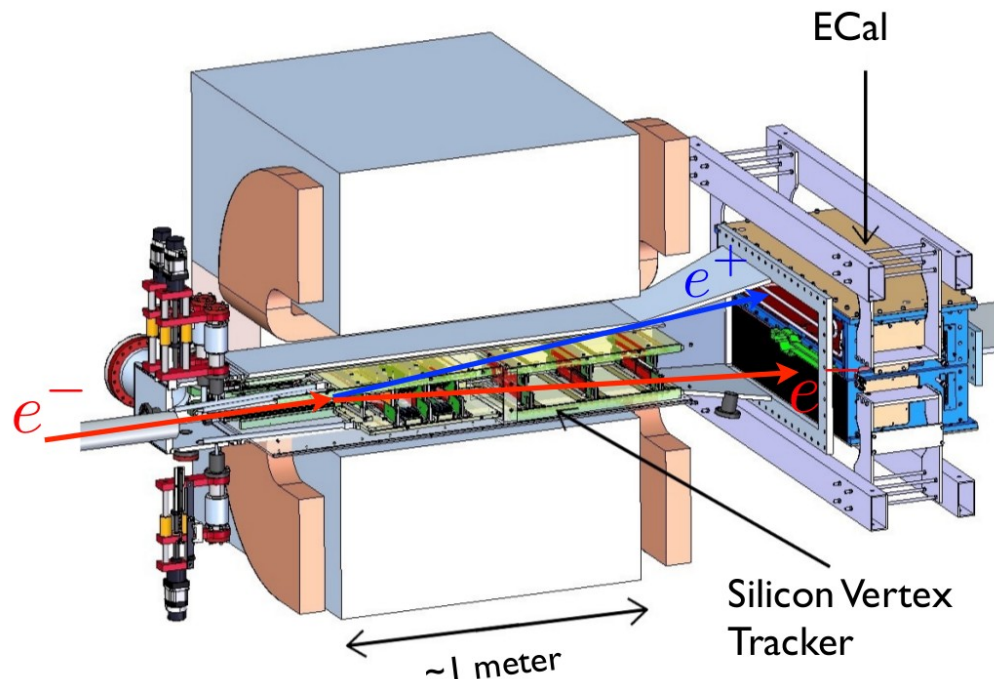


thermal targets
 $\alpha_D = 0.5, M_{A'}/M_\chi = 1.5$

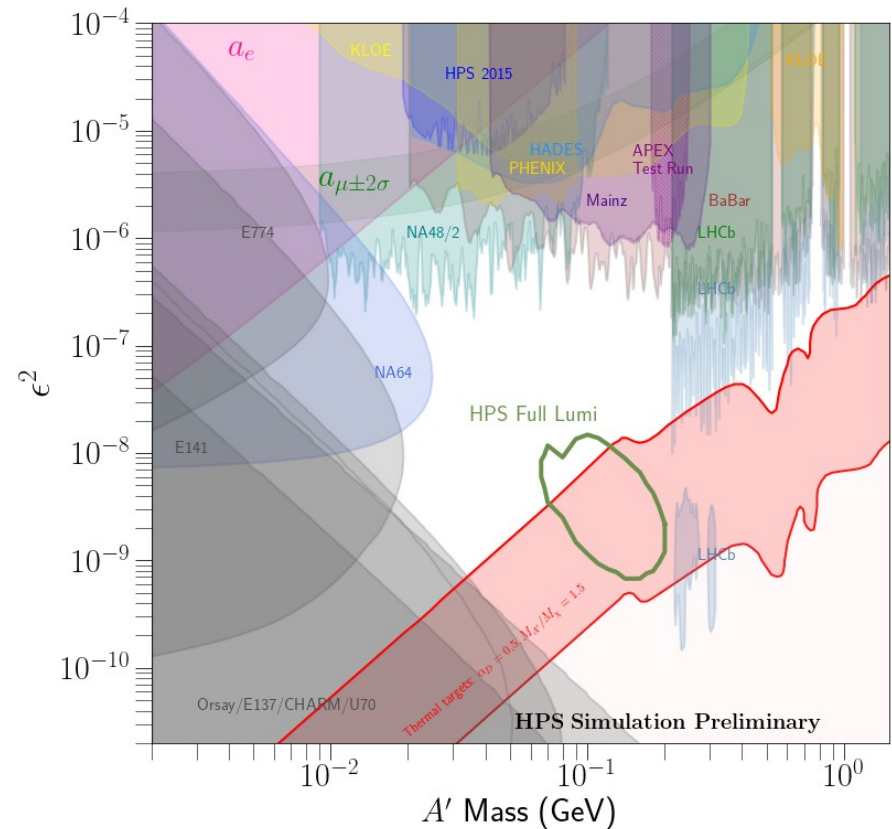
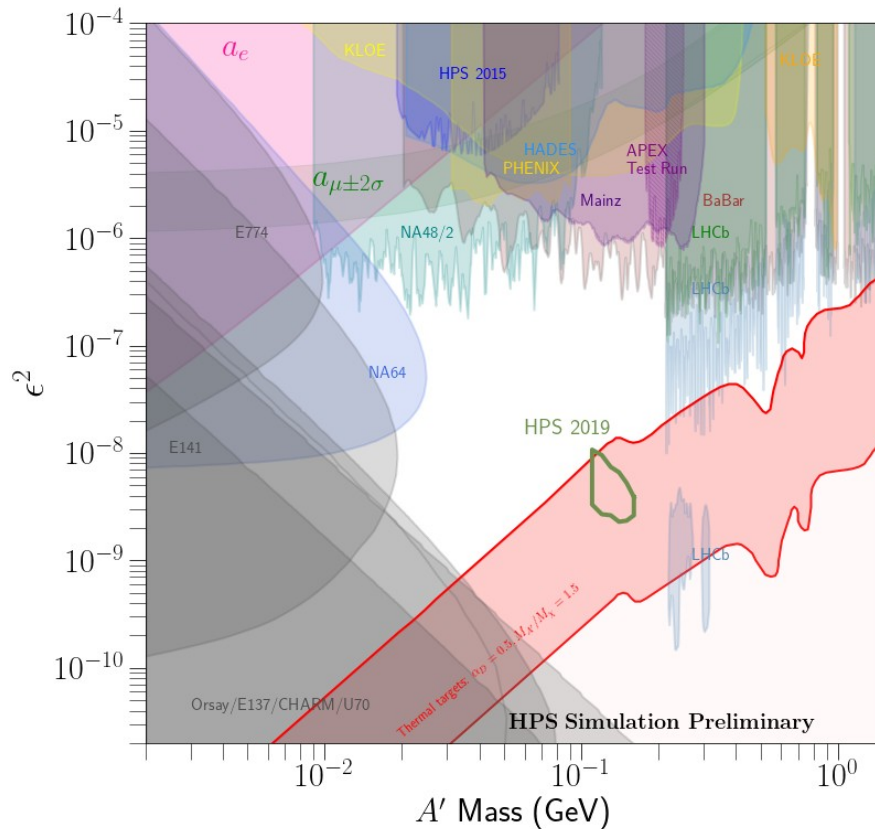
The HPS Apparatus @ JLab CEBAF

SLAC

- Compact e^+e^- spectrometer, immediately downstream of thin target in multi-GeV beam in Hall B
- Low-mass, high-rate (up to 4 MHz/mm²) silicon tracker (SVT) allows vertexing long-lived A'
- SVT must suppress SM tridents from target by factor $\sim 10^7$
- PbWO_4 Ecal trigger eliminates 10's MHz scattered single e^-
- Engineering runs in '15 and '16
- First physics run in '19, next run planned for summer '21
- Re-approved by JLab PAC for remaining 135 days of beamtime



Projected Displaced A' Reach



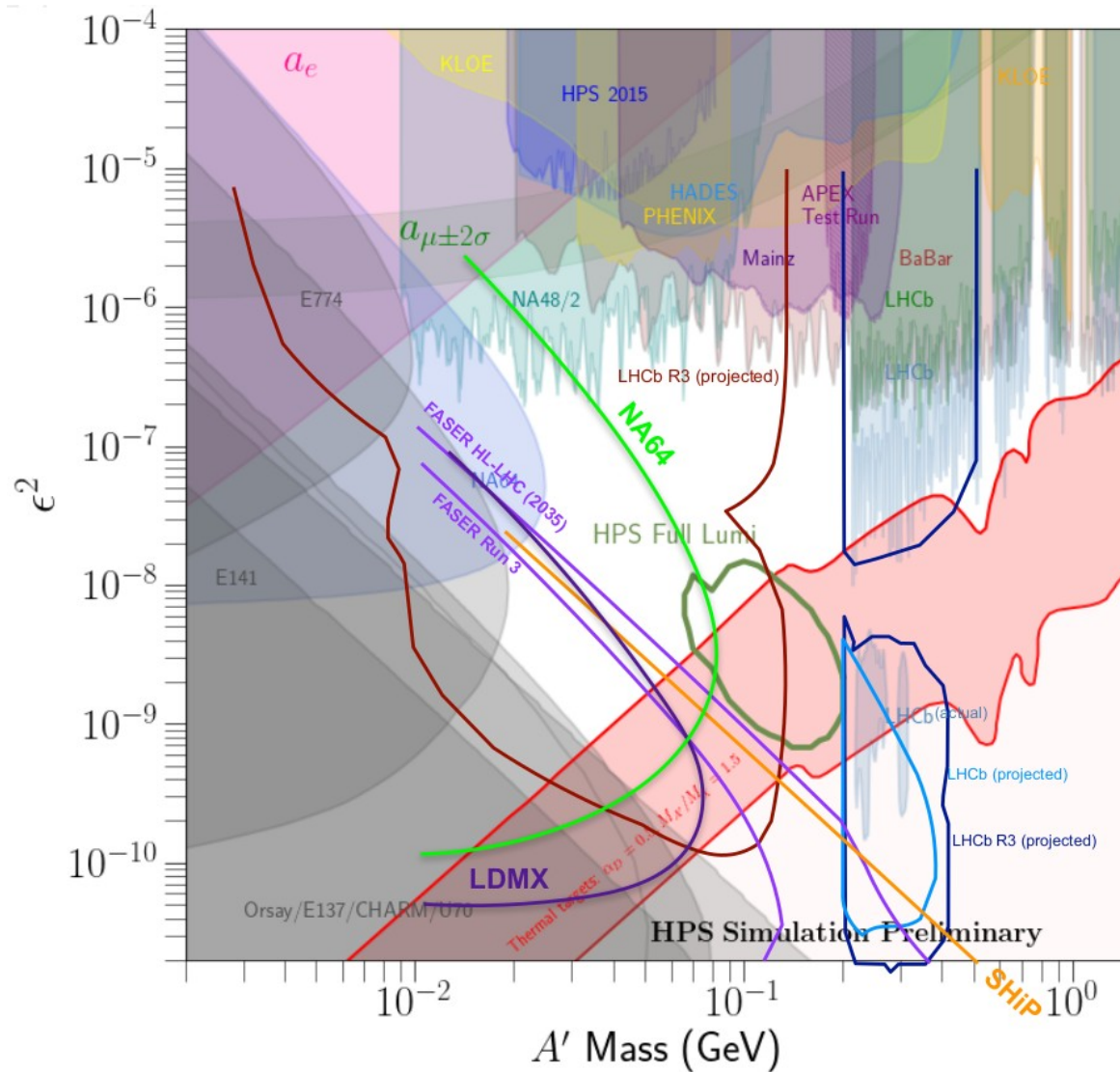
- HPS is projected to have sensitivity to highly motivated theory space
- Interested in growing our sensitivity beyond our already approved beam time
- Development of new detector configurations to target different regions

- HPS also has good sensitivity to other dark sector models that result in long-lived signatures
 - Axion-like particles (ALPs) have a straight forward re-interpretation of the minimal model
 - Strongly Interacting Massive Particles (SIMPs) will require new analysis since kinematics are different enough (already under development)
 - Inelastic Dark Matter (iDM) models have not been carefully explored in general yet, but could motivate new modes of operation of this already existing experiment
- New configurations of the apparatus discussed last snowmass, to search new A' space, could also be useful for these models

Joint Efforts and Snowmass Process

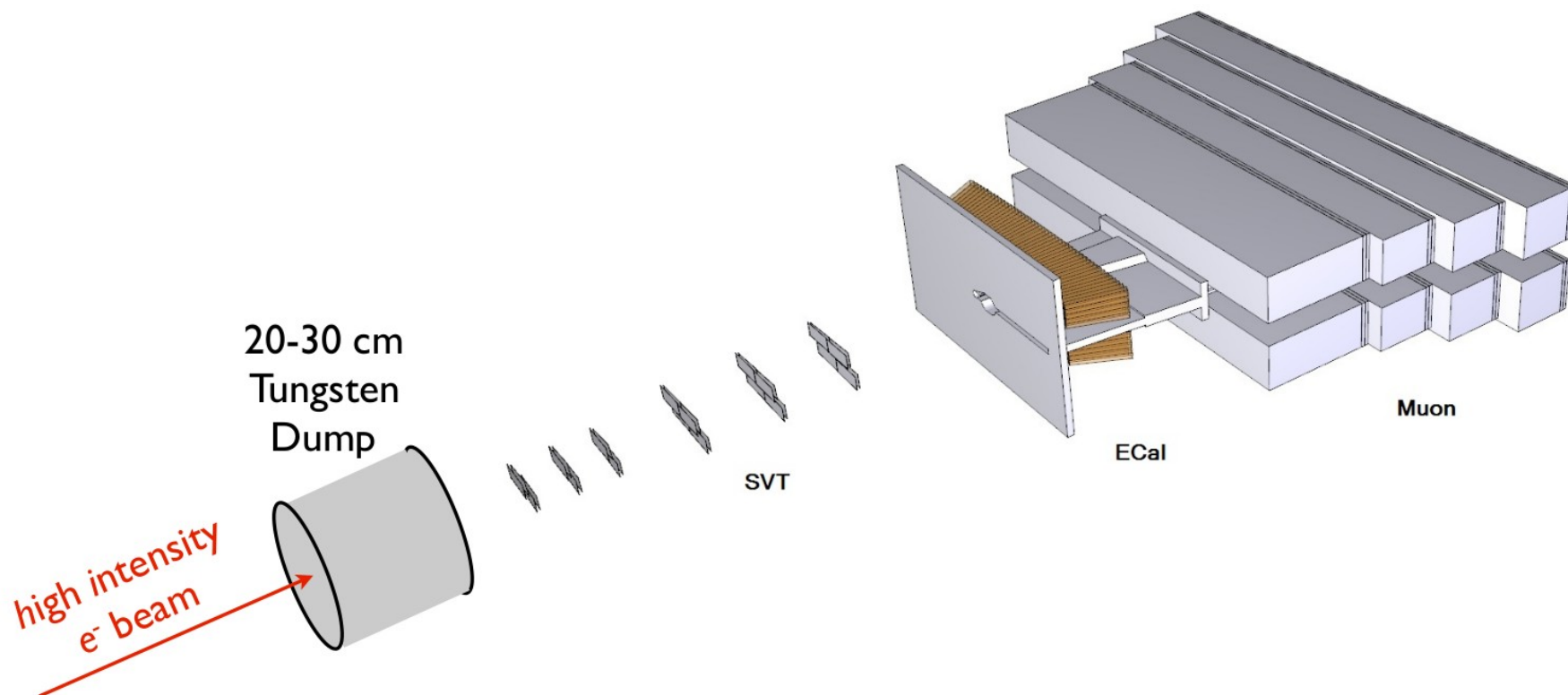
- Collaboration with theorists to develop benchmark models and tools needed to study a broader set of dark matter scenarios, e.g. iDM
- Potential opportunity for experiments to share software tools, in some cases
- We want Snowmass to build on the strong foundation created through the Cosmic Visions and BRN process in identifying high priority areas of exploration with clear motivations to develop similarly clear motivations for a broader set of dark sector scenarios, and put forward that physics as something that should be strongly endorsed by P5

Reach Estimates from Other Experiments



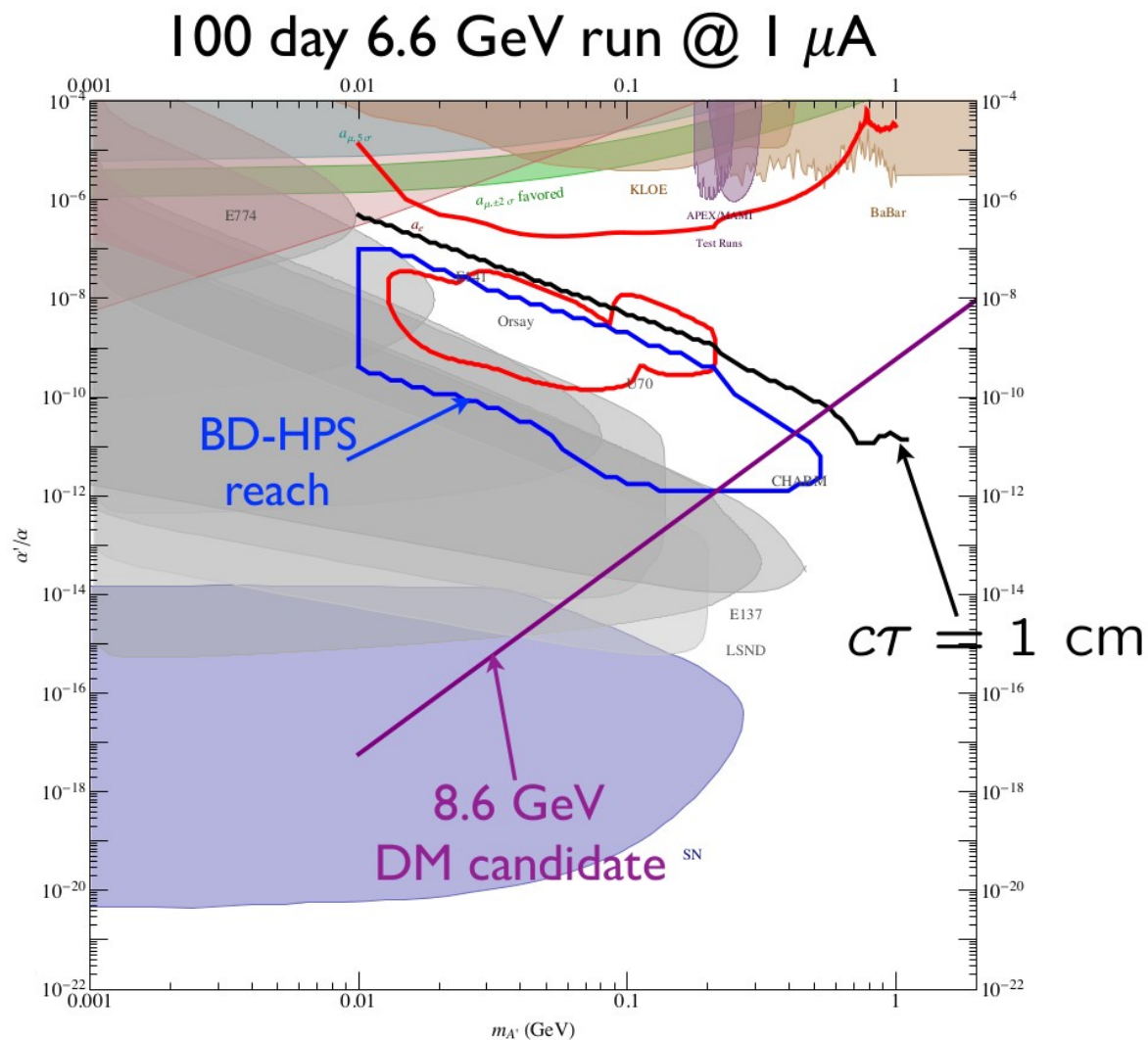
Beam Dump HPS Concept

Run HPS downstream of a shallow tungsten dump



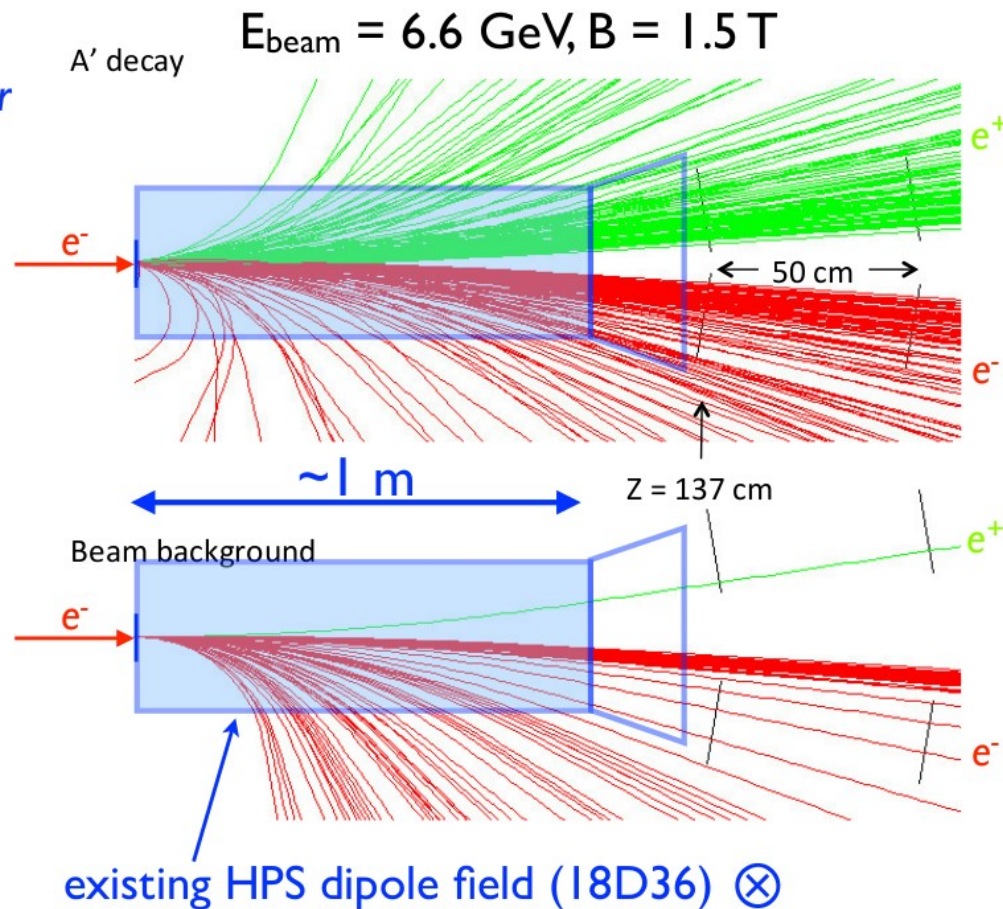
Huge increase in luminosity, eliminates EM backgrounds

Beam Dump HPS Reach

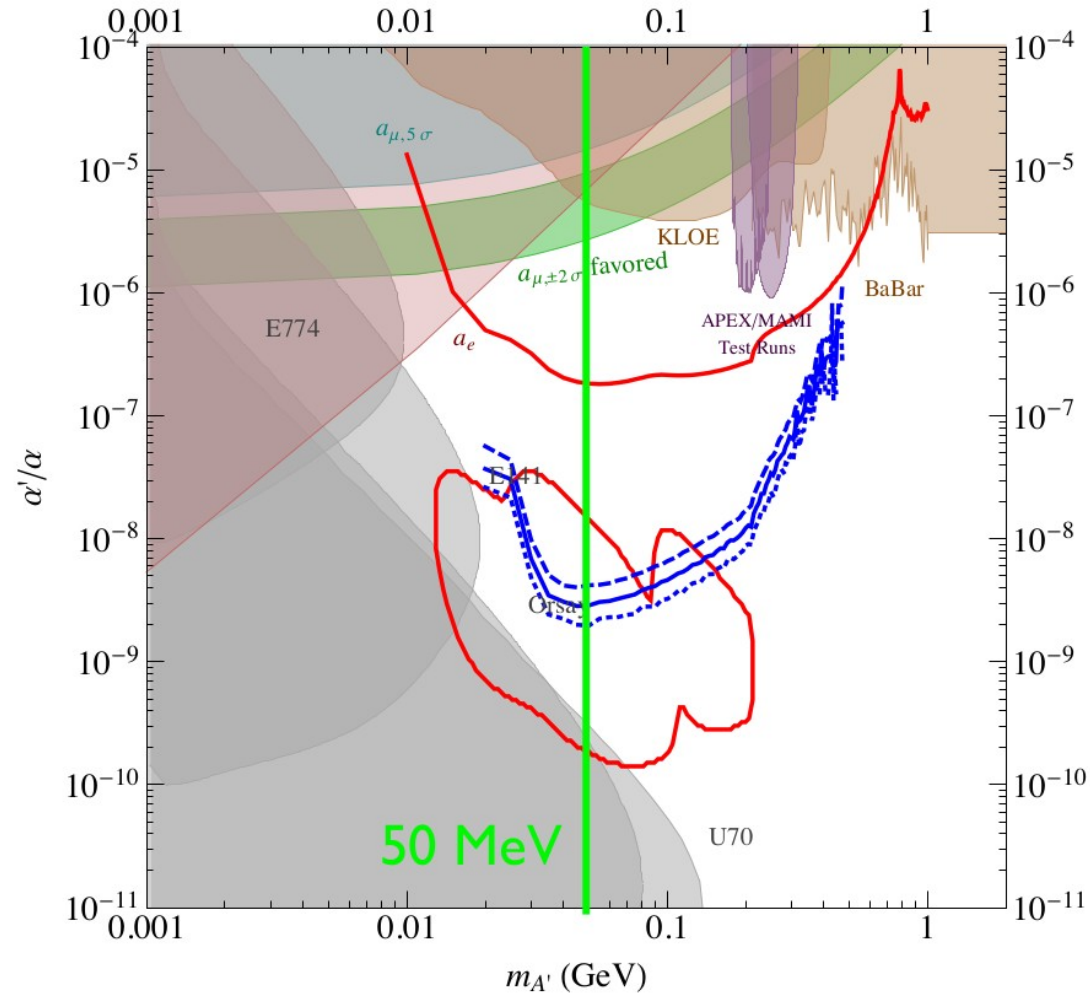


A high acceptance two-armed spectrometer

- Use distance to separate enormous flux of scattered beam-energy electrons from A' daughters
 - Use HPS detector technologies to allow for compact apparatus
- ➡ double-arm HPS downstream of existing dipole: similar to APEX but with much larger acceptance

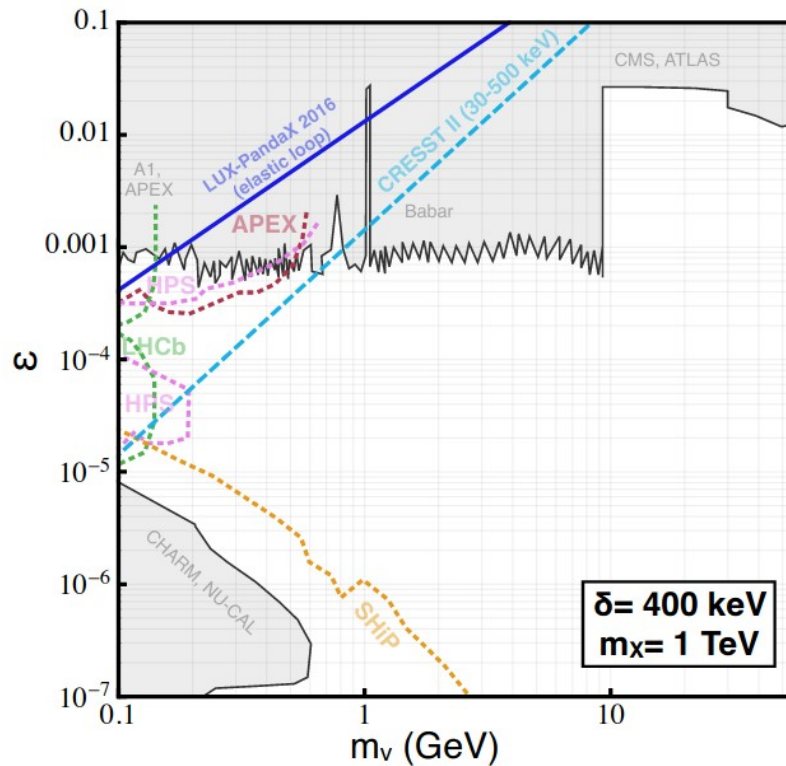


15 days a 10 μA w/ 2.5% X_0 target

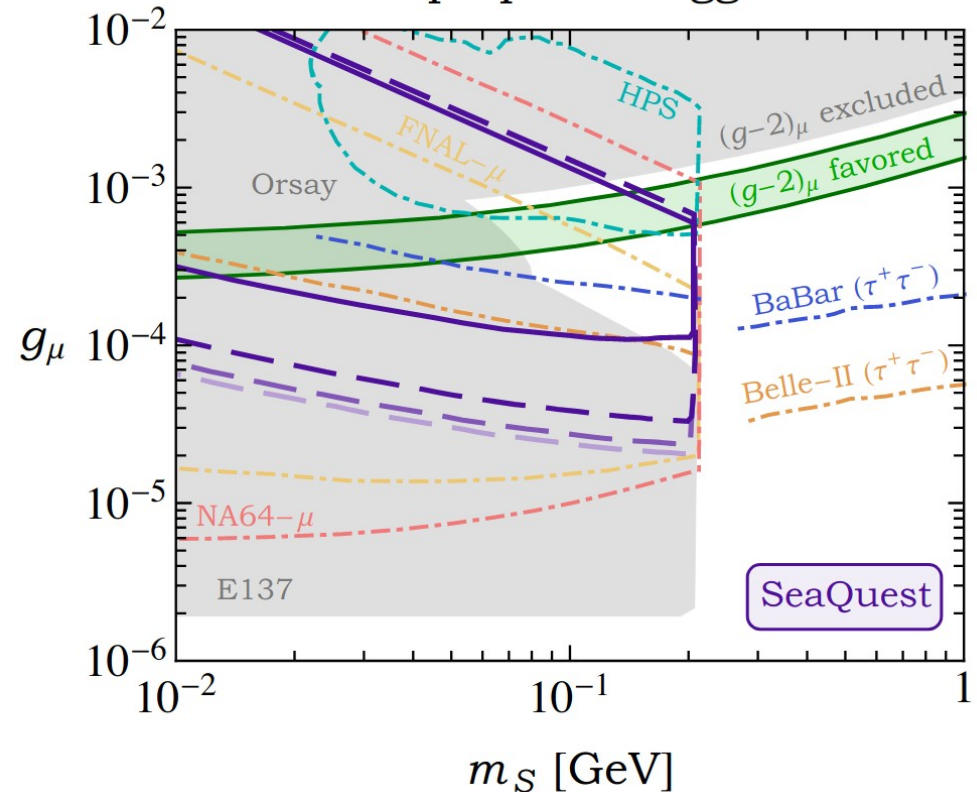


Reach Estimates for New Models

iDM



Leptophilic Higgs



<https://arxiv.org/pdf/1608.02662.pdf>

<https://arxiv.org/pdf/1804.00661.pdf>